

CLAIMS

1. In a vehicle comprising an internal combustion engine, a cranking motor coupled with the engine to crank the engine, and a battery coupled with the cranking motor, the improvement comprising:

5 a capacitor comprising first and second terminals;

10 first and second electrical paths interconnecting the first and second terminals, respectively, with the cranking motor and a system ground;

15 a first switch comprising a circuit positionable between at least an open and closed position, said first switch coupled to the battery;

20 a second switch comprising a first circuit coupled between said first switch and said system ground and a second circuit coupled between the first and second terminals of the capacitor, wherein said second switch is moveable between an on position and a momentary position; and

25 a relay included in the first electrical path and coupled to said second switch, said relay moveable between at least a closed-circuit condition, in which the relay completes the first electrical path, and an open-circuit condition, in which the relay interrupts the first electrical path, wherein the battery applies a first control voltage through said circuit of said first switch when said circuit of said first switch is in the closed position and through said first circuit of said second switch when said second switch is in the on position, and wherein said capacitor applies a second control voltage through said second circuit of said second switch when said second switch is in the momentary position, and wherein said relay is moveable to said closed-circuit condition in response to at least one of said first and second control voltages being applied thereto.

2. The invention of Claim 1 wherein said first switch comprises an ignition switch of the vehicle, wherein said circuit of said first switch is moveable to the closed position when said ignition switch is moved to at least one of a run and start position, and wherein said first switch is moveable to

the open position when said ignition switch is moved to at least one of an accessory and off position.

3. The invention of Claim 1 wherein said first switch comprises an ignition switch of the vehicle, wherein said circuit of said first switch is moveable to the closed position when said ignition switch is moved to a start position, and wherein said first switch is moveable to the open position when said ignition switch is moved to an off position.

4. The invention of Claim 1 wherein the relay comprises first and second control terminals, and wherein said second switch is coupled to said first and second control terminals.

5. The invention of Claim 5 further comprising third and fourth electrical paths interconnecting said second switch and said first and second relay control terminals.

6. The invention of claim 1 wherein said first switch comprises an oil pressure switch, wherein said circuit of said oil pressure switch is positionable in the closed position in response to at least a predetermined minimum oil pressure being applied to said oil pressure switch.

7. The invention of claim 6 wherein circuit of said oil pressure switch comprises a normally open circuit, and wherein said oil pressure switch further comprises a normally closed circuit, and further comprising a solenoid switch coupled to the cranking motor and comprising a solenoid terminal coupled to said normally closed circuit of said oil pressure switch, wherein said battery applies said first control voltage to said relay through said solenoid terminal, said normally closed circuit of said oil pressure switch and said first circuit of said second switch during engine cranking.

9. The invention of claim 1 wherein said capacitor comprises a double layer capacitor characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

10. In a vehicle comprising an internal combustion engine, a cranking motor coupled with the engine to crank the engine, and a battery coupled with the cranking motor, the improvement comprising:

5 a capacitor comprising first and second terminals;

first and second electrical paths interconnecting the first and second terminals, respectively, with the cranking motor and a system ground;

10 an oil pressure switch comprising a circuit positionable between at least an open and closed position, said oil pressure switch coupled to at least one of the battery and said capacitor; and

15 a relay included in the first electrical path and coupled to said oil pressure switch, said relay positionable between at least a closed-circuit condition, in which the relay completes the first electrical path, and an open-circuit condition, in which the relay interrupts the first electrical path, wherein said at least one of the battery and said capacitor apply a control voltage to said relay when said oil pressure switch circuit is positioned in said closed position, and wherein said relay is positioned in said closed-circuit condition in response to said control voltage being applied thereto when said oil pressure switch circuit is positioned in the closed position.

20 11. The invention of Claim 10 wherein the relay comprises first and second control terminals, and further comprising first and second diodes coupled between the second relay control terminal and the first electrical path on opposite sides of the relay respectively.

25 12. The invention of Claim 11 further comprising an electrical path coupling the oil pressure switch and the first relay control terminal.

13. The invention of claim 10 further comprising at least a predetermined minimum oil pressure applied to said oil pressure switch, and wherein said oil pressure switch circuit is positioned in the closed position in response to said predetermined minimum oil pressure being applied thereto.

14. The invention of claim 10 further comprising a solenoid switch coupled to the cranking motor and comprising a solenoid terminal applying said control voltage during engine cranking, and wherein said oil pressure switch circuit comprises a normally open circuit, and wherein said oil pressure switch further comprises a normally closed circuit coupled to said solenoid terminal, wherein said relay is moveable to said closed-circuit condition in response to said control voltage being applied thereto through said normally closed circuit of said oil pressure switch during engine cranking.

10 15. The invention of claim 10 wherein said control voltage is a first control voltage, and further comprising a momentary switch coupled between said first and second terminals of the capacitor and moveable to at least a momentary position, wherein said capacitor applies a second control voltage to said relay when said momentary switch is moved to said momentary position, and wherein said relay is moveable to said closed-circuit condition in response to said second control voltage being applied thereto.

20 25. The invention of claim 15 wherein said momentary switch is connected to said first and second terminals of said capacitor via third and fourth electrical paths, wherein said capacitor applies said second control voltage to said relay when said momentary switch is moved to said momentary position.

30 35. The invention of claim 15 wherein said momentary switch is further coupled between said relay and said oil pressure switch, and wherein said momentary switch is moveable between at least an on position and said momentary position, wherein said at least one of the battery and said capacitor applies said first control voltage to said relay when said momentary switch is moved to said on position and wherein said capacitor applies said second control voltage when said momentary switch is moved to said momentary closed position.

18. The invention of claim 15 wherein said first and second control voltages are substantially the same.

5 19. The invention of claim 10 wherein said capacitor is characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

10 20. The invention of claim 10 further comprising a solenoid switch coupled to the cranking motor and comprising a solenoid terminal applying said control voltage during engine cranking, and further comprising an electrical path connecting said solenoid terminal and said relay, and further comprising a diode disposed in said electrical path between said solenoid terminal and said relay.

15 21. The invention of claim 21 wherein said solenoid further comprises a battery terminal and a momentary switch coupled between the battery terminal and the relay, wherein said momentary switch is connected to said electrical path between said solenoid terminal and said relay at a location between said diode and said relay.

20 22. A method for cranking an internal combustion engine comprising:

25 providing an electrical system comprising a capacitor comprising first and second terminals interconnected with a cranking motor and a system ground by way of first and second electrical paths respectively; a first switch comprising a circuit positionable between at least an open and closed position, said first switch coupled to a battery; a second switch comprising a first circuit coupled between said first switch and said system ground and a second circuit coupled between the first and second terminals of the capacitor, wherein said second switch is positionable between an on position and a momentary position; and a relay included in the first electrical path and coupled to said second switch, said relay moveable between at least a

closed-circuit condition, in which the relay completes the first electrical path, and an open-circuit condition, in which the relay interrupts the first electrical path;

positioning said circuit of said first switch in said closed position;

5 positioning said second switch in said on position;

applying a first control voltage to said relay with said battery through said circuit of said first switch when said circuit of said first switch is in the closed position and through said first circuit of said second switch when said second switch is in the on position;

10 positioning said second switch in said momentary position;

applying a second control voltage to said relay with said capacitor through said second circuit of said second switch when said second switch is in the momentary position; and

positioning said relay in said closed-circuit condition in response to at least one of said first and second control voltages being applied thereto and thereby completing said first electrical path.

23. The method of Claim 22 wherein said first control voltage is insufficient to position said relay in said closed-circuit condition and wherein said positioning said relay in said closed-circuit condition comprises positioning said relay in said closed-circuit condition in response to said second control voltage being applied thereto.

24. The method of Claim 23 wherein said first control voltage is
25 approximately zero.

30 25. The method of Claim 22 wherein said first switch comprises an ignition switch of the vehicle, and wherein said positioning said circuit of said first switch in said closed position comprises moving said ignition switch to at least one of a run and start position, and further comprising positioning said circuit of said first switch in said open position by moving said ignition switch to at least one of an accessory and off position.

5 26. The method of Claim 22 wherein said first switch comprises an ignition switch of the vehicle, and wherein said positioning said circuit of said first switch in said closed position comprises moving said ignition switch to a start position, and further comprising positioning said circuit of said first switch in said open position by moving said ignition switch to an off position.

10 27. The method of Claim 22 wherein the relay comprises first and second control terminals, and wherein said second switch is coupled to said first and second control terminals.

15 28. The method of Claim 27 further comprising third and fourth electrical paths interconnecting said second switch and said first and second relay control terminals.

20 29. The method of claim 22 wherein said first switch comprises an oil pressure switch, wherein said positioning said circuit of said first switch in said closed position comprises applying at least a predetermined minimum oil pressure to said oil pressure switch.

25 30. The method of claim 29 wherein said circuit of said oil pressure switch comprises a normally open circuit, and wherein said oil pressure switch further comprises a normally closed circuit, and wherein said providing said electrical system further comprises providing a solenoid switch coupled to the cranking motor and comprising a solenoid terminal coupled to said normally closed circuit of said oil pressure switch, and wherein said applying said first control voltage to said relay with said battery through said circuit of said first switch comprises applying said first control voltage to said relay through said solenoid terminal, said normally closed circuit of said oil pressure switch and said normally closed circuit of said second switch during engine cranking.

31. The method of claim 22 wherein said capacitor comprises a double layer capacitor characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

32. A method for cranking an internal combustion engine comprising:

5 providing an electrical system comprising a capacitor comprising first and second terminals interconnected with a cranking motor and a system ground by way of a first and second electrical paths respectively; an oil pressure switch comprising a circuit positionable between at least an open and closed position, said oil pressure switch coupled to at least one of a battery and said capacitor; and a relay included in the first electrical path and coupled to said oil pressure switch, said relay moveable between at least a closed-circuit condition, in which the relay completes the first electrical path, and an open-circuit condition, in which the relay interrupts the first electrical path;

10 applying at least a minimum predetermined oil pressure to said oil pressure switch and thereby positioning said circuit of said oil pressure switch in said closed position;

15 applying a control voltage to said relay with said at least one of the battery and said capacitor when said oil pressure switch circuit is positioned in said closed position; and

20 positioning said relay in said closed-circuit condition in response to said control voltage being applied thereto and thereby completing said first electrical path.

25 33. The method of Claim 32 wherein the relay comprises first and second control terminals, and wherein said providing said electrical system further comprises providing first and second diodes coupled between the second relay control terminal and the first electrical path on opposite sides of the relay respectively.

30 34. The method of Claim 33 wherein said providing said electrical system further comprises providing an electrical path coupling the oil pressure switch and the first relay control terminal.

35. The method of claim 32 wherein said providing said electrical system further comprises providing a solenoid switch coupled to the cranking motor and comprising a solenoid terminal, and wherein said circuit of said oil pressure switch comprises a normally open circuit and wherein said oil pressure switch further comprises a normally closed circuit coupled to said solenoid terminal, and further comprising cranking said engine and applying said control voltage through said solenoid terminal and said normally closed circuit of said oil pressure switch during said engine cranking.

10 36. The method of claim 32 wherein said control voltage is a first control voltage, and wherein said providing said electrical system further comprises providing a momentary switch coupled between the first and second terminals of the capacitor and moveable between at least an on position and a momentary position, and further comprising moving said momentary switch to said momentary position and applying a second control voltage with said capacitor to said relay when said momentary switch is moved to said momentary position, and wherein said positioning said relay in said closed-circuit condition in response to said control voltage being applied thereto comprises positioning said relay in said closed-circuit condition in response to said second control voltage being applied thereto.

15 20 37. The method of claim 36 wherein said providing said electrical system comprises providing third and fourth electrical paths connecting said momentary switch and said first and second terminals of said capacitor.

25 38. The method of claim 36 wherein said momentary switch is further coupled between said relay and said oil pressure switch, and wherein said applying first control voltage comprises positioning said momentary switch in said on position.

30 39. The method of claim 36 wherein said first and second control voltages are substantially the same.

5 40. The method of claim 36 wherein said providing said electrical system further comprises providing a solenoid switch coupled to the cranking motor and comprising a solenoid terminal coupled to said relay with an electrical path, wherein a diode is disposed in said electrical path between said solenoid terminal and said relay, and further comprising cranking said engine and applying said control voltage through said solenoid terminal and said electrical path to said relay during engine cranking.

10 41. The method of claim 40 wherein said solenoid further comprises a battery terminal and wherein said providing said electrical system further comprises providing a momentary switch coupled between the battery terminal and the relay, wherein said momentary switch is connected to said electrical path between said solenoid terminal and said relay at a location between said diode and said relay, and further comprising closing said momentary switch and charging said capacitor with at least one of said battery and an external charging device, whereby said diode prevents current from flowing to said solenoid terminal.

15 42. The method of claim 32 wherein said capacitor is characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

20 43. The method of claim 42 wherein said capacitor is characterized by an internal resistance at 1 kHz and 20°C less than 0.008 ohms.